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Method for Manufacturing Multiple Thermoelectric Element Unit

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BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view illustrating the structure of a multiple thermoelectric element unit obtained through a manufacturing method according to the present invention; FIG. 2 is an oblique view illustrating an example of use of the multiple thermoelectric element unit; and FIG. 3 is a plan view illustrating an example of another structure for a multiple thermoelectric element unit obtained through a manufacturing method as set forth in the present invention.

DETAILED EXPLANATION OF THE INVENTION

The present invention relates to a method for manufacturing a multiple thermoelectric element unit. As is well-known, a thermoelectric element device uses direct current, where the maximum direct current Iopt is given by:

$$Iopt = \alpha\ Tc\ \rho/Sl.$$

Where α is the Seebeck coefficient, Tc is the temperature (in °K) on the heat absorbing side, ρ is the resistivity, S is the cross-sectional area of the element, and l is the length of the element.

As is clear from the relationships in the equation above, if α, Tc, and ρ are held constant, then Iopt is determined by the magnitude of S and l when a rectified current from an alternating current is used as the working power supply. If the ripple in the current is not caused to the less than about 10% then it will not be possible to produce adequate functionality. Because of this, when the Iopt is large, then the current rectifying device, of necessity, must also be large as well, and thus preferably Iopt is as small as possible. By the equation above, in order to cause Iopt to be small, elements wherein S is small and l is large should be used; however, having l be large is not suitable for use because this would increase the amount of the material that is used, and would cause the size of the device to be large as well. Because of this, it is more effective to make S small. Conventional thermoelectric element devices have been manufactured by arranging alternatingly P-type and N-type thermoelectric elements manufactured through a casting method or a sintering method, and connecting alternatingly the ends of adjacent P-type and N-type elements using conductive plates, to fabricate units wherein multiple elements are connected in series, and then bonding, in an electrically insulating manner, thermally conductive plates to the outside surfaces of thermally conductive plates [sic] to the outside surfaces of the electrically conductive plates, to form a thermoelectric device, and thus with the conventional thermoelectric device it is necessary to use the thin element rods in order to cause the Iopt to be small. However, the elements produced through the aforementioned casting method or sintering method are brittle, so there is a limitation on the size thereof from the perspective of mechanical strength, where an element with an Iopt of about one amp was the limit of what could be manufactured, and it obtaining an element rod of less than that has been extremely difficult.

The present invention is to provide a method for manufacturing a multiple thermoelectric element unit with an extremely small electric current, improving the shortcoming set forth above, and will be explained the in detail below in reference to the figures.

As illustrated in FIG. 1, after depositing P-type and N-type metal thin film element bands 2 and 3 alternatingly, essentially in parallel to each other, with a specific spacing through a specific mask using a low-pressure vapor deposition method or a sputtering method onto a substrate ribbon 1 of a flexible and electrically insulating material that has low thermal conductivity, such

as craft paper, the end portions of adjacent P-type and N-type metal films in the deposited metal film are alternatingly shorted together through depositing a metal conductive thin film 4, following which lead wires 5 are connected to the respective metal conductor thin films 4' that are connected to the P-type and N-type metal films that are at the respective ends of the substrate ribbon 1, to form a set of series-connected thermoelectric elements 10 that is flexible.

It the multiple thermoelectric element unit that has been formed as described above is rolled into a cylinder as illustrated in FIG. 2a or folded back on itself into layers as illustrated in FIG. 2c, and then is filled with a moisture-proof resin, such as an epoxy resin, to form a single unit, and then, as illustrated in FIG. 3b, has a thermally conductive plate 6 attached, in an electrically insulating way, to the end portion to which the metal conductor thin film was deposited, to thereby form the thermoelectric element device.

In practice, in a device wherein the method of the present invention was used to deposit 66 pairs of P-type and N-type metal thin film bands, of a $(Bi, Sb)_2(Te, Se)_3$ system, each 1 mm wide with a thickness of 1 μm, with a spacing of 0.5 mm, onto one side of a craft paper that was 5 mm wide, 200 mm long, and 0.05 mm thick, with an Sn conductive thin film formed through low-pressure vapor deposition onto the end portions of the metal layer bands so as to connect in series these P-type and N-type metal layer bands, after which the result was rolled into a cylindrical shape and filled with a liquid epoxy resin to form a single unit, with an alumite thermally conductive plate bonded to both ends thereof using an epoxy adhesive, the maximum electric current value for the Iopt was 1 mA, and at that time the temperature difference ΔT, when the temperature Th of the contact point was 27°C, was 35°. Note that the voltage across the terminals was 5.5 V.

Note that a case is described wherein adjacent end portions in the thermoelectric element metal films are connected together through a metal conductive thin film is described above, but, as illustrated in FIG. 3, instead the multiple thermoelectric element unit 20 may be formed by series-connecting the end portions of alternating adjacent metal layers directly, wherein the end portions of the metal element film bands 11 and 12 are shaped so as to have bends that extend toward each other, where doing so eliminates the deposition of the conductive metal film such as in the multiple thermoelectric element unit of FIG. 1, described above. Furthermore, while in the description above there was an explanation of depositing the thermoelectric element metal films on one side of an insulating ribbon, instead the films may be deposited on both sides, of course. Furthermore, while the illustration is of a case wherein the thermoelectric metal layers are deposited so as to be essentially perpendicular to the lengthwise direction of the substrate ribbon, these need not necessarily be perpendicular, but rather, of course, may be deposited at any angle.

The present invention, having the structure set forth above, enables the easy manufacturing of a multiple thermoelectric element unit for low electric currents, of 1A and below, where operations such as manufacturing large quantities of the element sets all at once and cutting off the required number of elements for assembling is also extremely effective in terms of manufacturing efficiency. Furthermore, design changes for the devices can be performed simply by varying the widths and thicknesses of the layers, and there are also additional benefits such as eliminating completely, through the present method, defects in bonding the electrically conductive plate, but which have caused defects in the conventional product.

Scope of Patent Claims

1. A method for manufacturing a multiple thermoelectric element unit wherein:

P-type and N-type thermoelectric element metal layer bands are deposited alternatingly, with a specific spacing therebetween, on a flexible, electrically insulating ribbon surface, where adjacent end portions of the deposited thermoelectric element metal layer bands have individual thermoelectric element metal thin films, and are connected either directly or through a conductive metal layer.

Cited References:

Japanese Examined Patent Application Publication S40-22142

FIG. 1

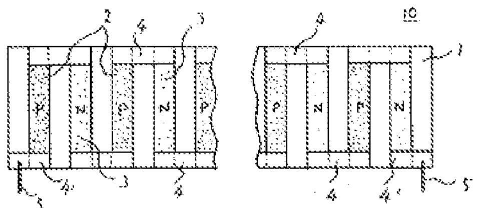


FIG. 2

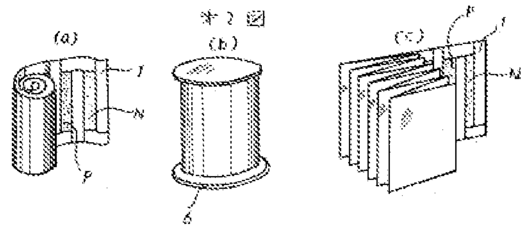
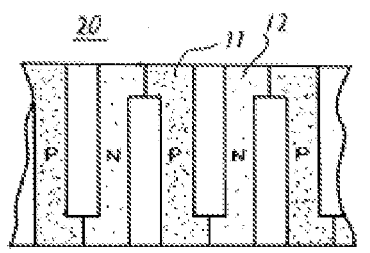


FIG. 3



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特　許　庁
特　許　公　報

特許出願公告
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公告　昭43.11.1
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熱電素子群体の製造方法

特　　願　昭　41－72857
出 願 日　昭　41.11.7
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図面の簡単な説明

第1図は本発明に係る製造方法によつて得られる熱電素子群体の構成を示す平面図、第2図は同上熱電素子群体の使用例を示す斜視図、第3図は本発明に係る製造方法によつて得られる熱電素子群体の他の構造例を示す平面図である。

発明の詳細な説明

本発明は熱電素子群体の製造方法に関する。熱電素子装置は直流で行われその最適電流値I optは周知の通り

$$\mathrm{I\,opt}=\frac{\alpha \mathrm{T} c \rho}{\mathrm{S}\ell}$$

（ここにαはゼーベック係数、Tcは吸熱側の温度（°K）、ρは比抵抗、Sは素子の断面積、ℓは素子の長さである。）

で表わされる。上式の関係から明らかなようにα、Tcおよびρが一定ならばIoptはSとℓの大きさによつて決定される。作動電源として交流を整流して用いる場合には電流のリツプルを約10％以下にしないと充分な性能を発揮させることが出来ない。このためIoptが大きいと整流装置も大型の物を必要とするようになるのでIoptは出来るだけ小さいことが望ましい。Ioptを小さくするためには前式よりSが小さくℓが大きい素子を用いればよいことになるがℓを大きくすることは使用素材の量が増えまた装置の形状が大きくなるので使用上不適当となる。このためSを小さくする方が効果的である。しかるに従来の熱電素子装置は鋳造法や焼結法で製造されたP型およびN型の熱電素子を交互に配列し相隣るP型、N型素子の端部を交互に導電板で接合して直列接続の素子群体を形成し、さらに導電板の外面に伝熱板の外面に伝熱板を電気絶縁的に固着して熱電装置に形成しているので、上記従来の装置でIoptを小さくするためには細い素子棒を使用する必要がある。しかし上記の鋳造法や焼結法による素子はもろく機械的強度の点でその大きさに制限がありIoptが1A程度の素子が製作可能の限度でそれ以下の素子棒を得ることはきわめて困難であつた。

本発明は上記の欠点を改良した微小電流用熱電素子群体の製造方法を提供するもので以下図面により詳細に説明する。

第1図に示すように熱伝導率が小さく可撓性の電気絶縁材料例えばクラフト紙の基体リボン1に真空蒸着法またはスパツタリング法等により所定のマスクを通してP型およびN型の金属薄膜素子帯2，3を所定の間隔で交互にほぼ並行して被着させた後該被着金属膜の相隣るP型、N型金属膜の両端部を交互に金属導電薄膜4の被着により短絡し、さらに基体リボン1の両端にあるP型、N型金属膜に接する金属導電薄膜4′にリード線5をそれぞれ接続することによつて可撓性のある直列熱電素子群体10を形成させる。

上記のごとくにして形成させた熱電素子群体は第2図aに示すように筒状に巻き上げたりまたは第2図cのように折り曲げて重ね合わせた後防湿性の樹脂例えばエポキシ樹脂を含浸させて一体に固化して第3図bに示すように金属導電薄膜を被着させた端部に伝熱板6を電気絶縁的に取着して熱電素子装置に形成させる。

実際上記本発明の方法により幅5㎜、長さ200㎜、厚さ0.05㎜のクラフト紙の片面に（Bi，Sb）$_2$（Te，Se）$_3$系のP型、N型金属薄膜帯を幅1㎜、厚さ1μ、間隔0.5㎜で66対被着し、該P型、N型の金属薄膜帯を直列接続となるように該金属膜帯の両端部にSnの導電薄膜を真空蒸着した後円筒状に巻回しエポキシ樹脂液に浸漬して一体に固化し、両端にアルマイトの伝熱板をエポキシ系接着剤で固着した装置ではIoptの最適電流値は1mAで、そのときの温度差△Tは熱接点の温度Th＝27℃のとき35°であつた。なお端子間電圧は5.5Vである。

なお上記の熱電素子金属膜は相隣る端部を金属

導電薄膜を介して導電的に接続した場合について述べたが第3図に示すように金属素子膜帯11，12の端部が互に反対方向に屈曲延長した形状に被着し該端部で直接相隣る金属膜を交互に接合させて直列接続した熱電素子群体20を形成させるようにすることも可能で、このようにすれば前記第1図の熱電素子群体のような導電金属膜の被着を省略することが出来る。さらにまた上記説明では熱電素子金属膜を絶縁リボンの片面に被着したものについて説明したが両面に被着してもよいことはいうまでもない。また熱電素子金属膜を基体リボンの長手方向にほぼ直角に被着した場合について図示したが、必ずしも直角である必要はなく任意の角度に被着してよいのは勿論である。

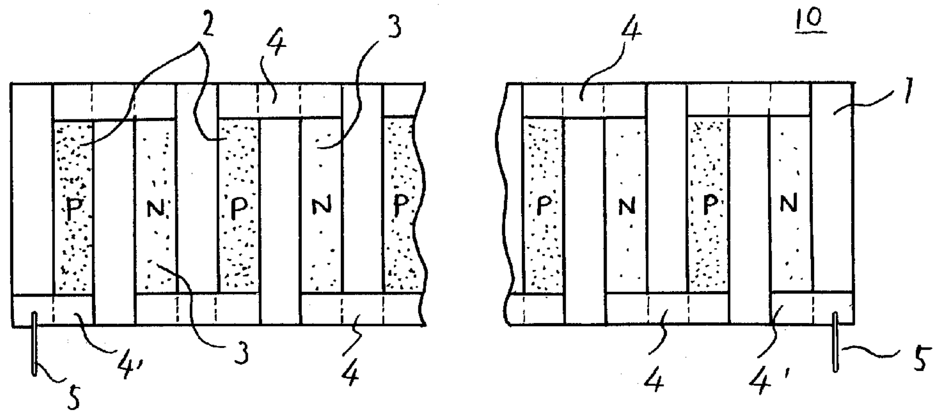
本発明は上記構成を有するため1A以下の低電流用熱電素子群体を容易に製作することが可能でありまた素子群は一度に多数対製作し必要に応じた素子対数を切り取つて組立てる等の作業も可能で製作能率上著しく有効である。さらに装置の設計変更の場合には被膜の幅、厚さを変更するのみで簡単に行うことが可能であり、さらにまた従来品の不良原因であつた導電板の接着不良は本方法においては皆無となる等種々の利点を有する。

特許請求の範囲

1　可撓性電気絶縁リボン面上に所定の間隔で交互にP型およびN型熱電素子金属膜帯を被着し、該被着された熱電素子金属膜帯の相隣る両端部を各熱電素子金属薄膜をもつて直接にまたは導電金属膜を介して接続することを特徴とする熱電素子群体の製造方法。

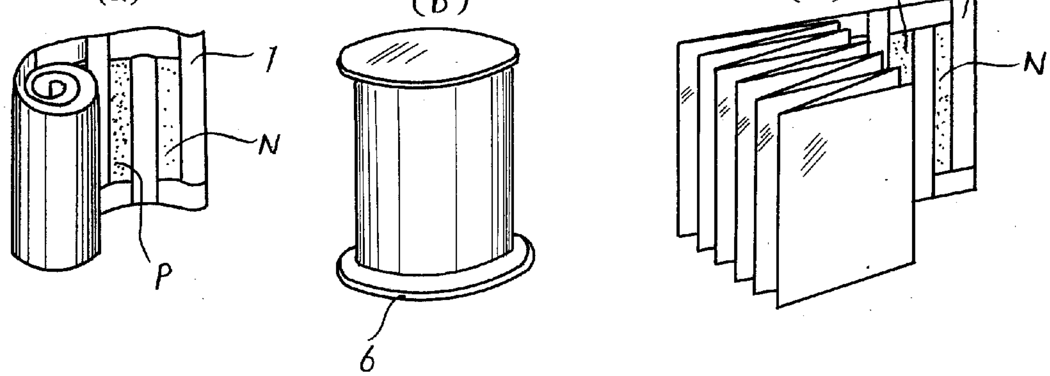
引用文献
特　　公　昭40－22142

第1図



第2図

(a) (b) (c)



第3図